December 1968

Brief 68-10566

NASA TECH BRIEF

Welding Skate with Computerized Controls

A prototype of a new welding skate concept for automatic TIG welding of contoured or double-contoured parts is being developed. It combines lightweight welding apparatus with electrical circuitry which computes the desired torch angle and positions a torch and cold-wire guide-angle manipulator. Control is maintained without contact of the work surface by mechanical, electromechanical, or photoelectric transducers. In addition, the computer circuit instantly computes the proper welding skate drive motor speed thereby correcting the skate velocity to maintain constant weld speed over contoured work surfaces. The system employs velocity and position transducers mounted remotely from the torch and work; thus, the torch and wire guide have maximum freedom to maneuver in restricted places. Of major importance is the fact that all controls for TIG welding are based on instantaneous conditions at the point of the arc rather than at a transducer mounted adjacent to the arc. The computer derives most of its input information as a result of the standard TIG welding process; so it does not interfere with, or attempt to regulate, the conventional TIG welding-process voltage and current controls.

The need for such a device arose from past attempts to automatically precision-weld contoured and double-contoured metal joints. Closed loop control transducers, whose purpose was to maintain the TIG torch and cold-wire feed at a fixed angle with respect to the work, either interfered with the process, were destroyed by heat, or were unreliable. In addition to the control problems, tooling costs were a factor in the skate development because the same equipment can be utilized to perform a multitude of welding operations with a minimum of down time. A lightweight carriage moves around the work with its associated weld manipulators, often reducing tooling costs for large weldments.

Speed control of the weld arc is vital and very difficult to achieve under conditions where the skate track and/or part is alternately curved and straight. This computer controlled skate concept compensates for large inherent mechanically induced velocity errors with a uniquely simple analog computer.

Control and computation for the torch angle and welding velocity are based on two distinct concepts. The torch angle computer solves for the instantaneous angle between tangents to the track and the work at the intersection point of the welding arc. These tangents form two sides of a right triangle. It is further demonstrated, through diagrams, that this angle is also the included angle between a line through the arc which parallels the torch voltage control manipulator actuator and a line normal to the work surface at the arc. The followup closed loop servo maintains the torch at some fixed relation to a normal erected at the point of intersection of the welding arc and the work surface. This control is accomplished by interrelating voltage analogs of the welding velocity and the torch velocity away or toward the welding skate carriage.

To compute the desired welding speed compensation, the circuit utilizes additional instantaneous voltage analogs of the radius of curvature of the skate track, the distance from the track to the work, and the cosine of the angle computed by the torch angle computer.

The advantages of computer control are numerous because of the independence of the control inputs

(continued overleaf)

from the condition of the work surface. Large voltage analogs of the required computer inputs are easily obtained. This advantage makes the computer controls stable during welding and also economical to construct.

Note:

Documentation may be obtained from:

Clearinghouse for Federal Scientific and Technical Information
Springfield, Virginia 22151
Price $3.00
Reference: B68-10566

Patent status:

This invention is owned by NASA and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

Source: W. A. Wall, Jr. and Vaughn H. Yost
Marshall Space Flight Center
(MFS-20224)